An Epidemiologic Study of Temperature and Mortality in California: Implications for Climate Change

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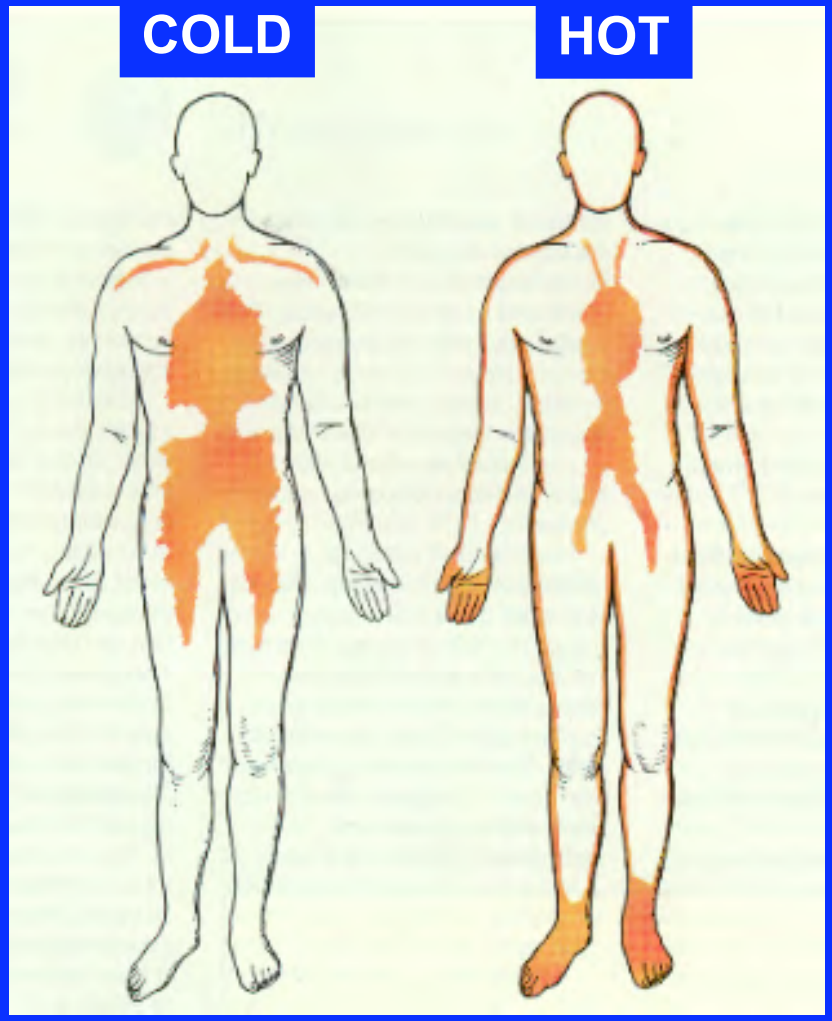
Public Health Significance

- 400 annual heat-related deaths in US (CDC 2002)
- Increase with global warming
  - In years with severe heat waves ~1,700 deaths
  - 2003 European heat wave: >6,000 excess deaths in Italy and 9 French cities
  - 140 deaths reported during July 2006 CA heat wave
- Heat-related deaths underreported

Mechanisms for Thermoregulation



Source: Moffett et al. 1993

1) Shift in blood circulation

2) Stress on heart

3) Sweating

Populations at Risk

- Elderly
- People with pre-existing diseases
- People taking certain medications
- Infants
- Low socioeconomic status
- Socially isolated populations

Background

- Few epidemiologic studies of temperature quantifying mortality risk
- Estimates not always comparable
- Previous studies did not always control for confounding by pollutants and other factors
  - Ostro et al. 2006: PM2.5 and mortality, adjusting for temperature and humidity

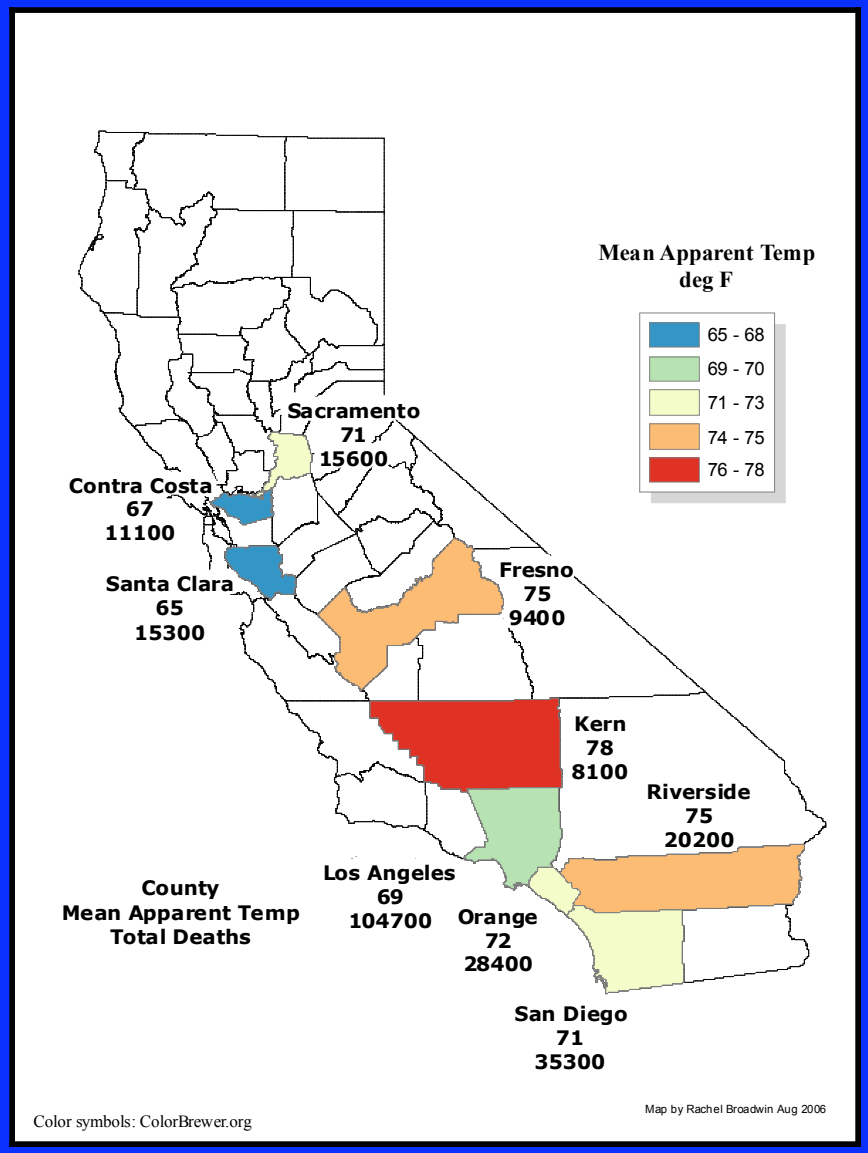
Study Objectives

- To assess the impact of apparent temperature on mortality in 9 CA counties
  - May 1-September 30, 1999-2003
- To determine how this association differs by cause-specific outcomes, race, age, education level, gender

Data

- Mean daily apparent temperature (EPA AIRS database)
  - Incorporates temperature and relative humidity
- Daily mortality (CA Department of Health Services)
  - All-cause
  - All-cause by gender, age, race, education
  - Cause-specific
- Air pollutants (CA Air Resources Board)
  - $PM_{2.5}$, O_3, CO, NO_2

Mean Daily Apparent Temperature (°F) for Nine California Counties, May-September 1999-2003



Data Analysis

- Time-series and case-crossover methods
  - Basu et al. 2005
- Separate analyses by county
- County estimates combined in meta-analysis
- Parallel study by Harvard group of 9 non-CA counties

Time-series Study Design

- Often used for air pollution studies
- Examine association between daily apparent temperature and daily mortality counts
- Adjust for all other factors that change over time

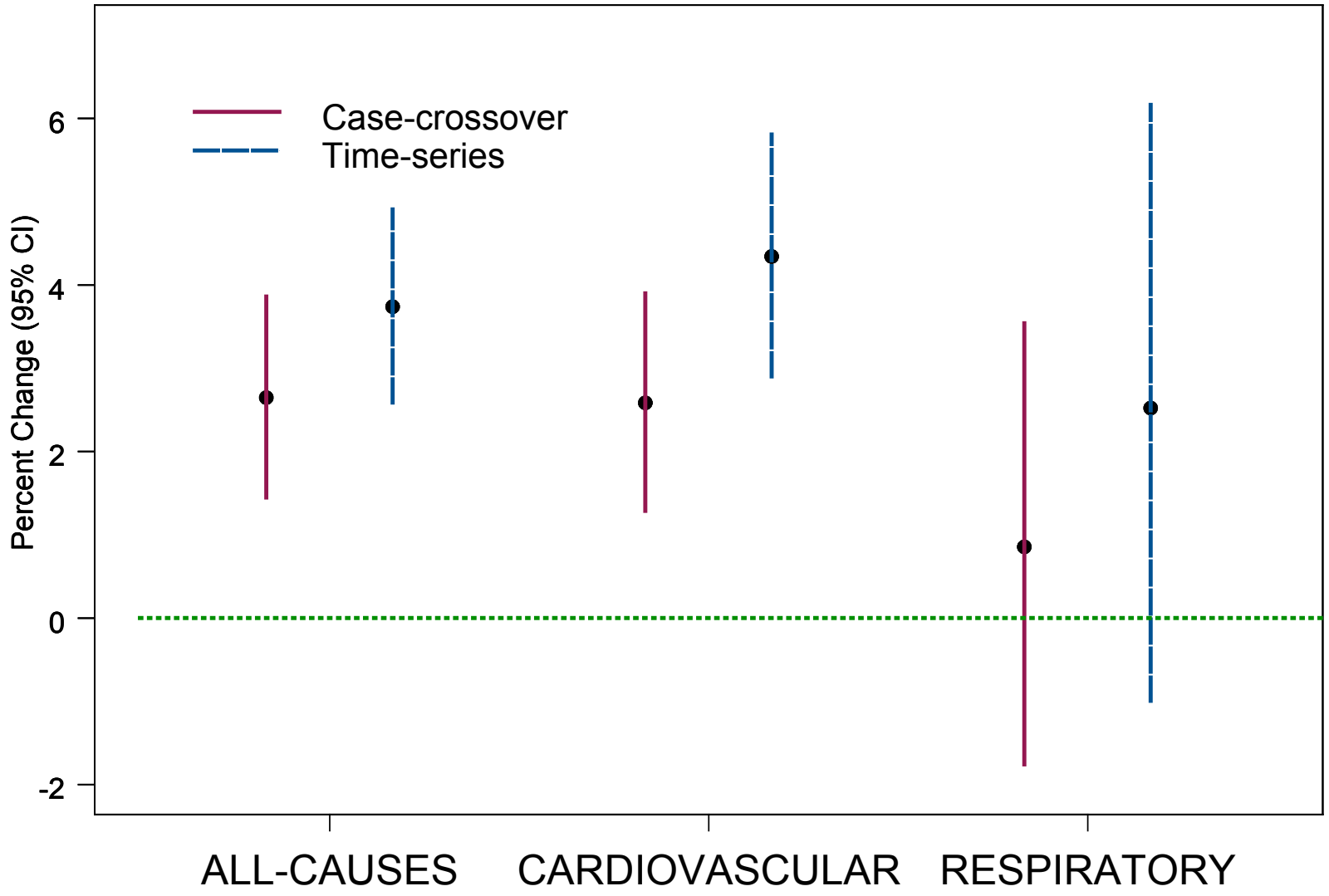
Case-crossover Study Design

- Compare temperature on day of death (case) to temperature on different days for same person when death did not occur (control)

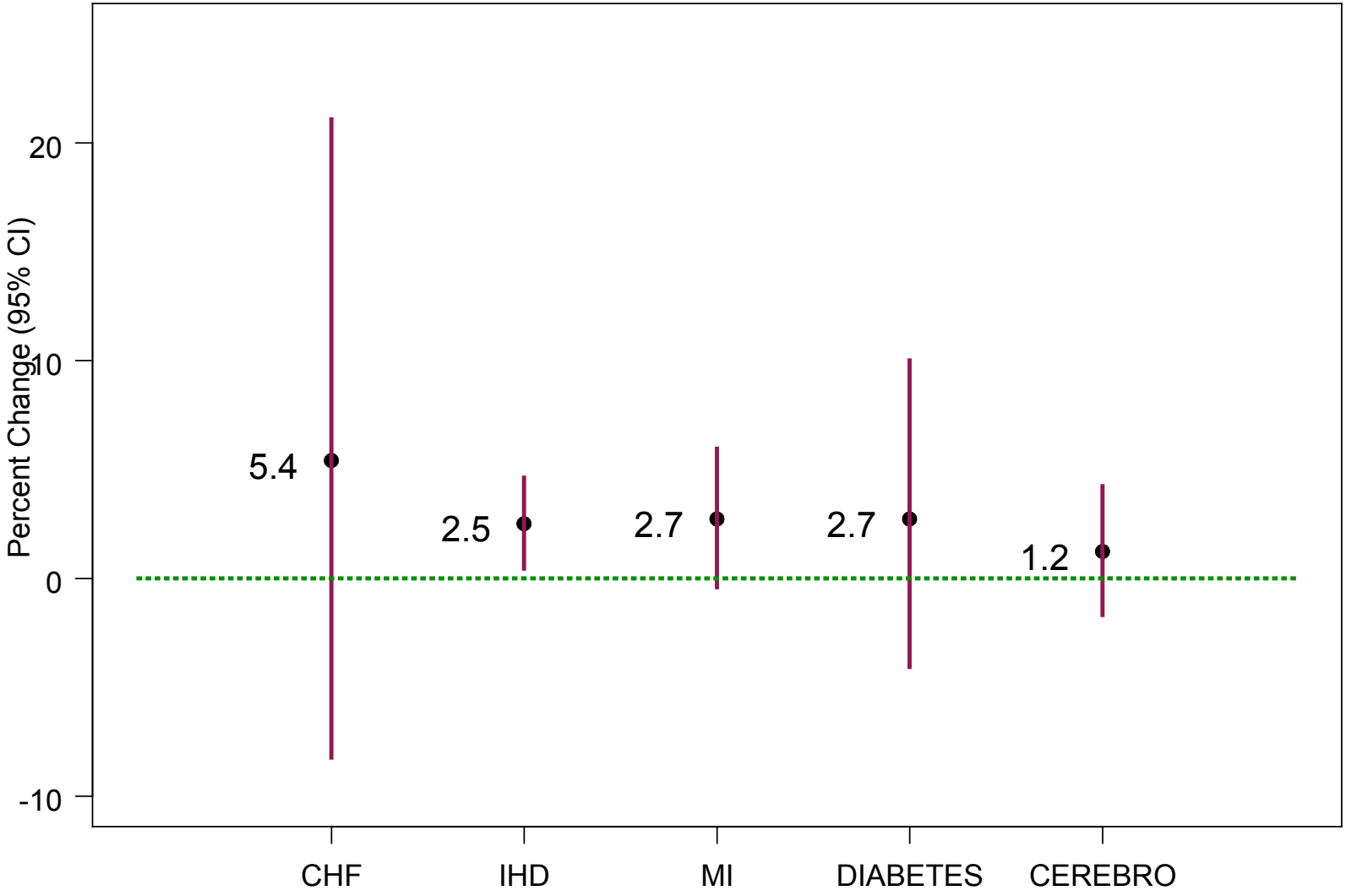
- Choose control periods within the same month as the cases
  - –Addresses concerns about effects of seasonality and other time-varying factors

Preliminary Results

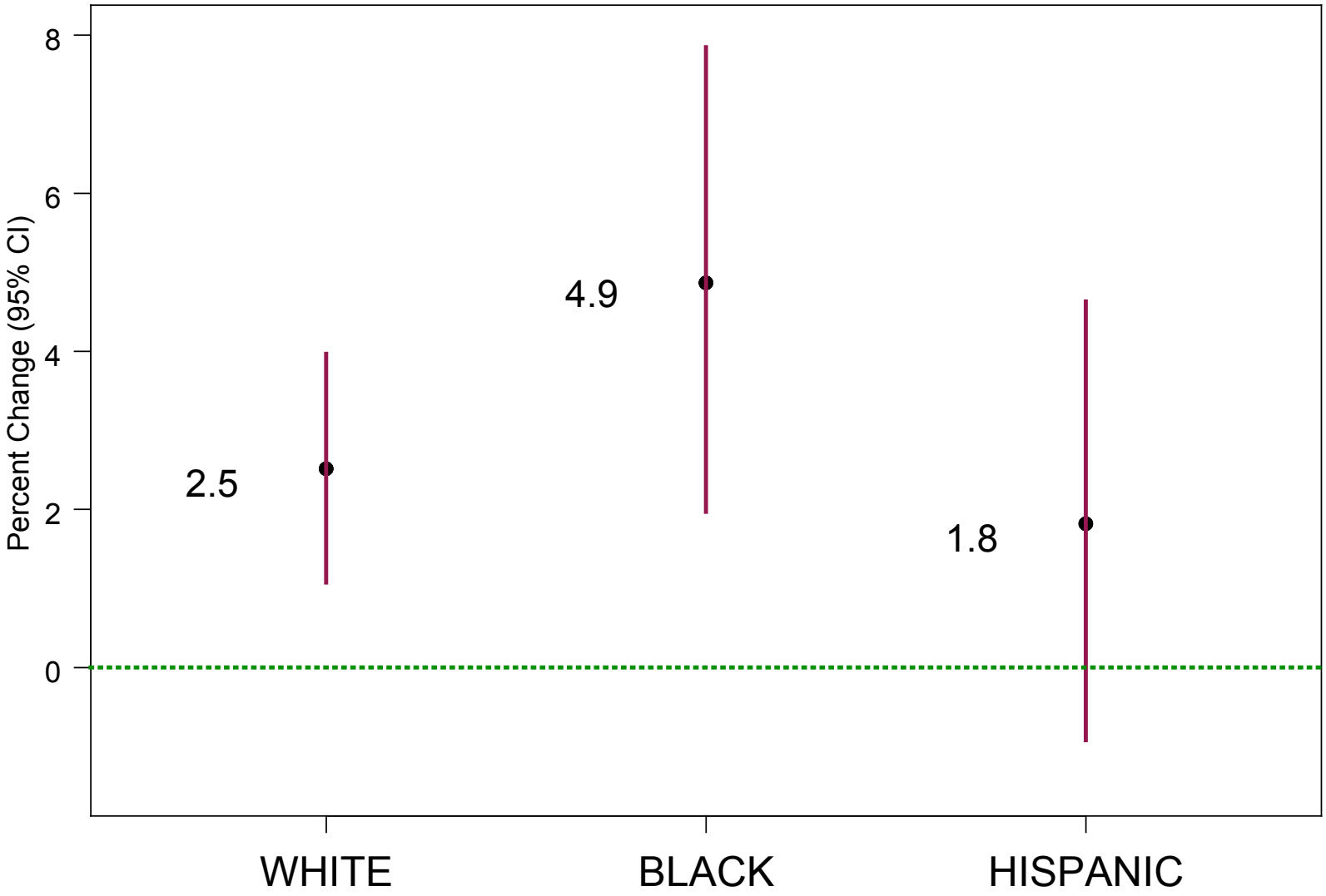
Apparent Temperature per 10ºF and Mortality



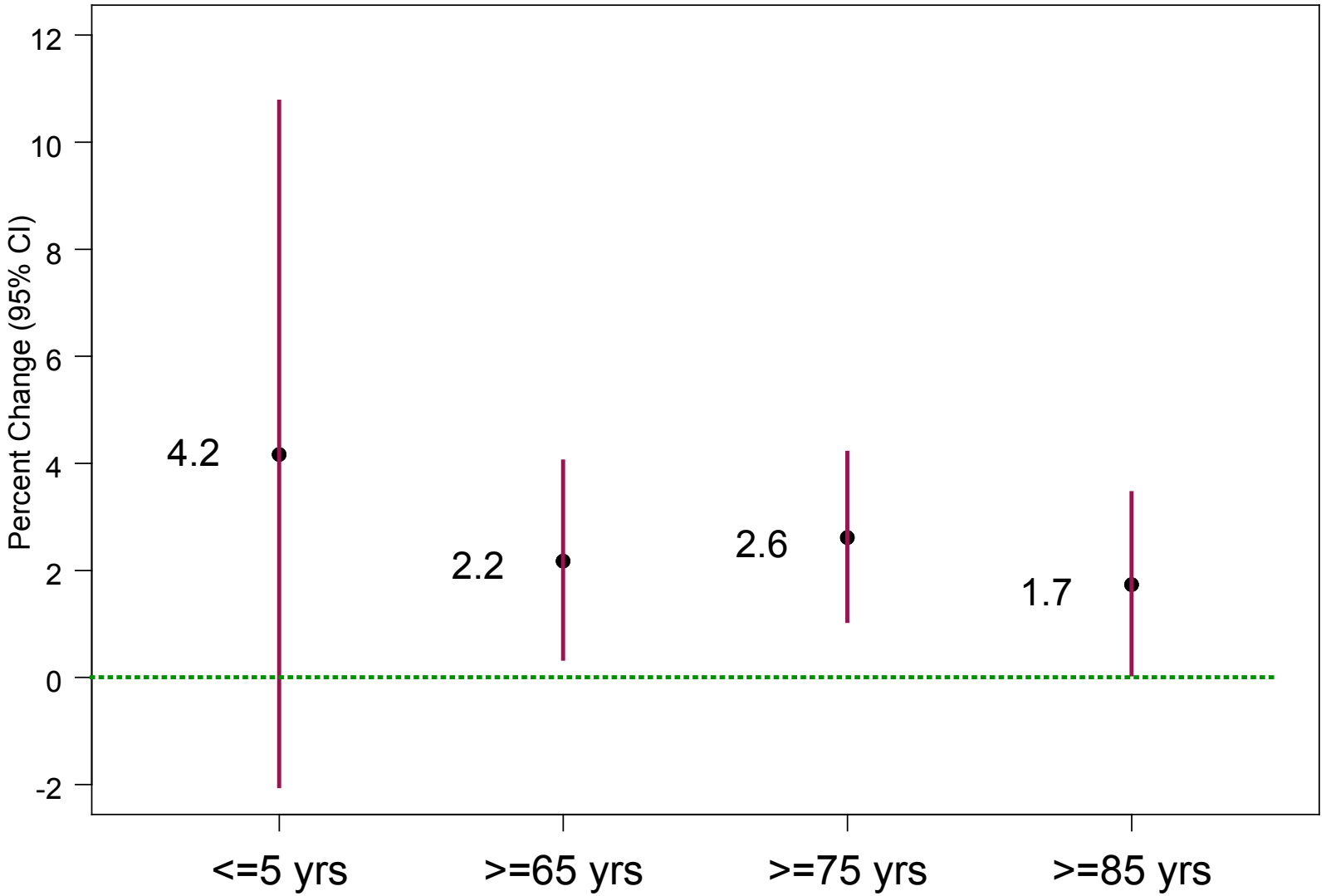
Apparent Temperature per 10ºF and Disease-specific Mortality



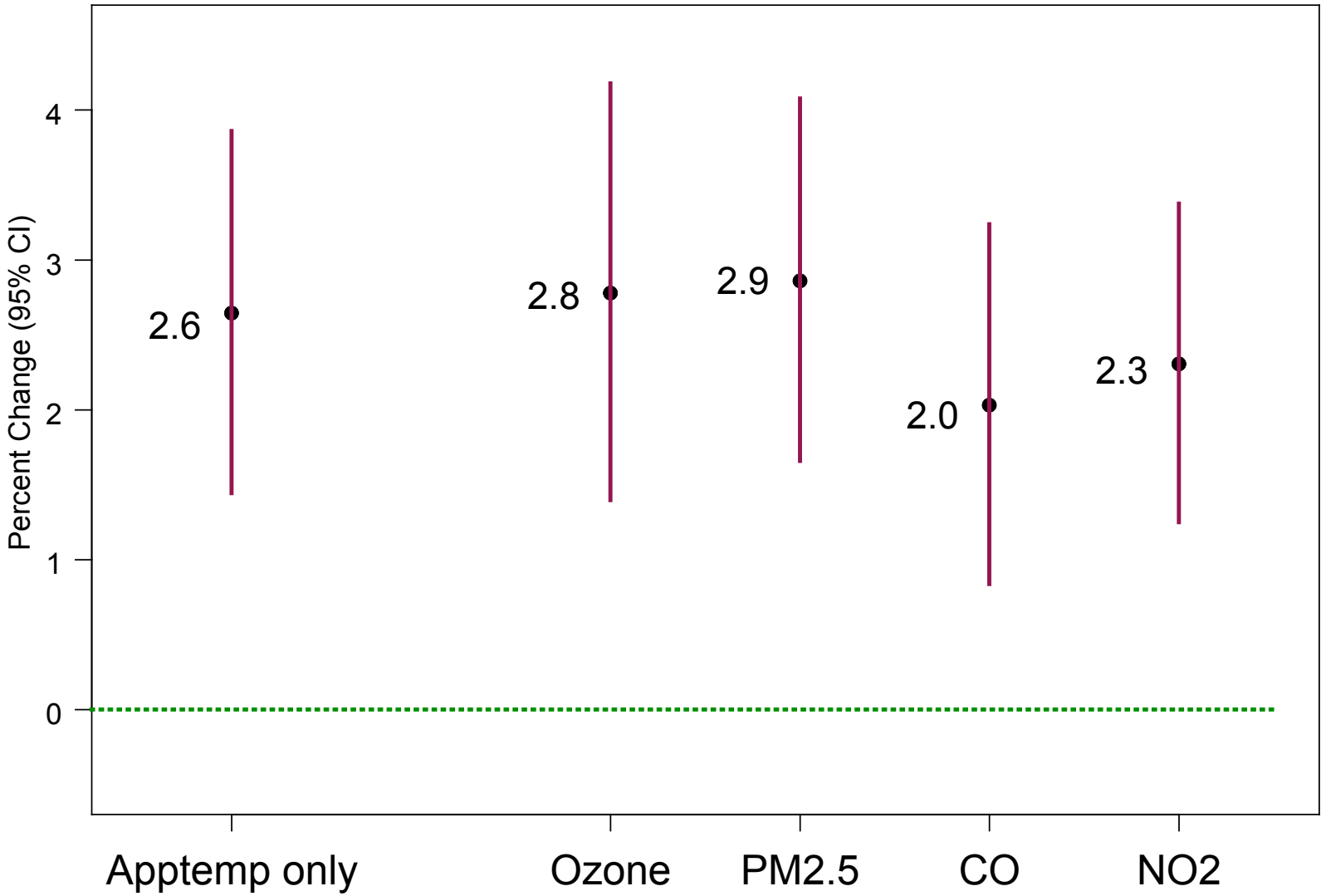
Apparent Temperature per 10ºF and All-cause Mortality by Race



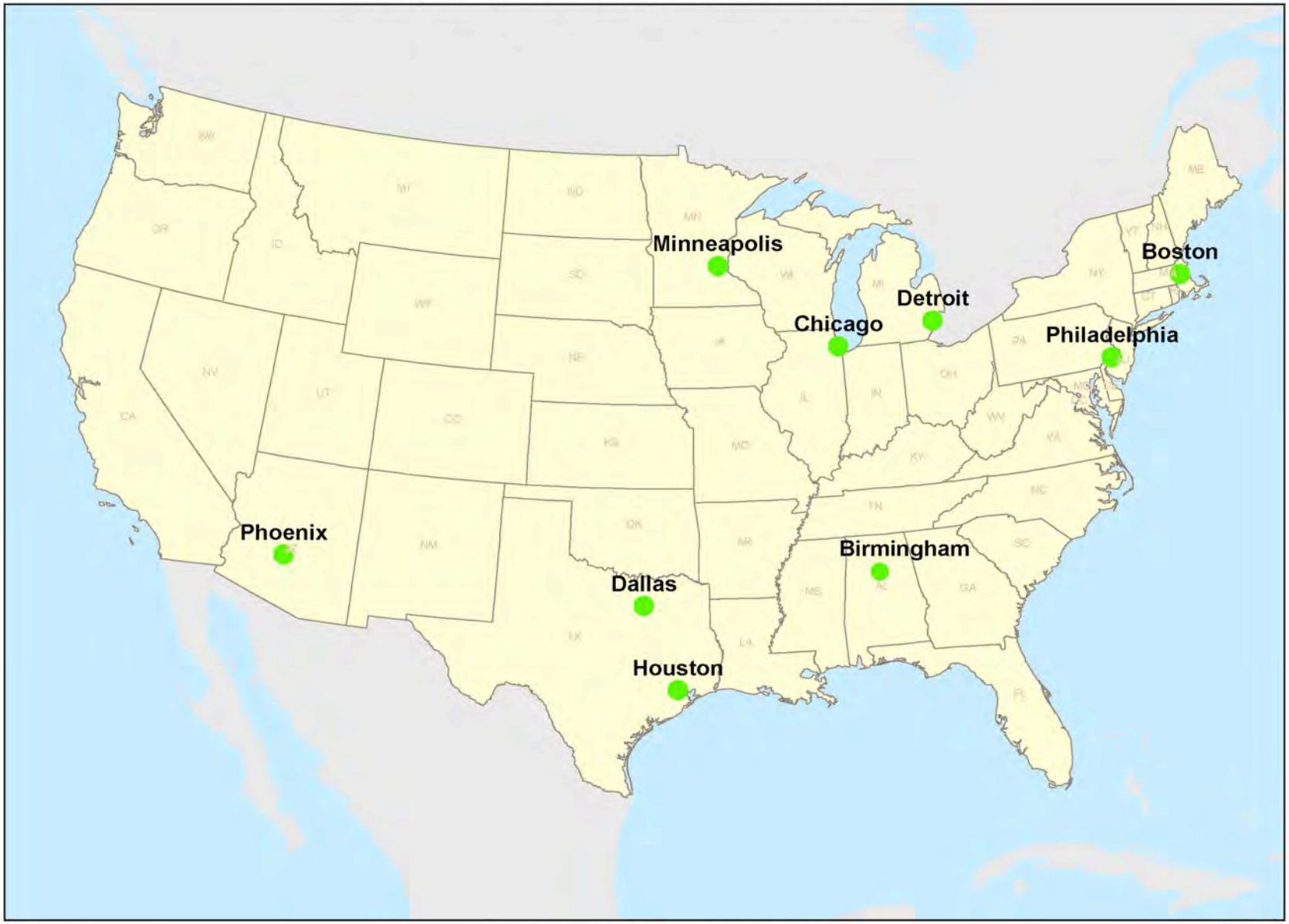
Apparent Temperature per 10°F and All-cause Mortality by Age Group



Apparent Temperature per 10°F and All-cause Mortality Adjusted by Pollutant

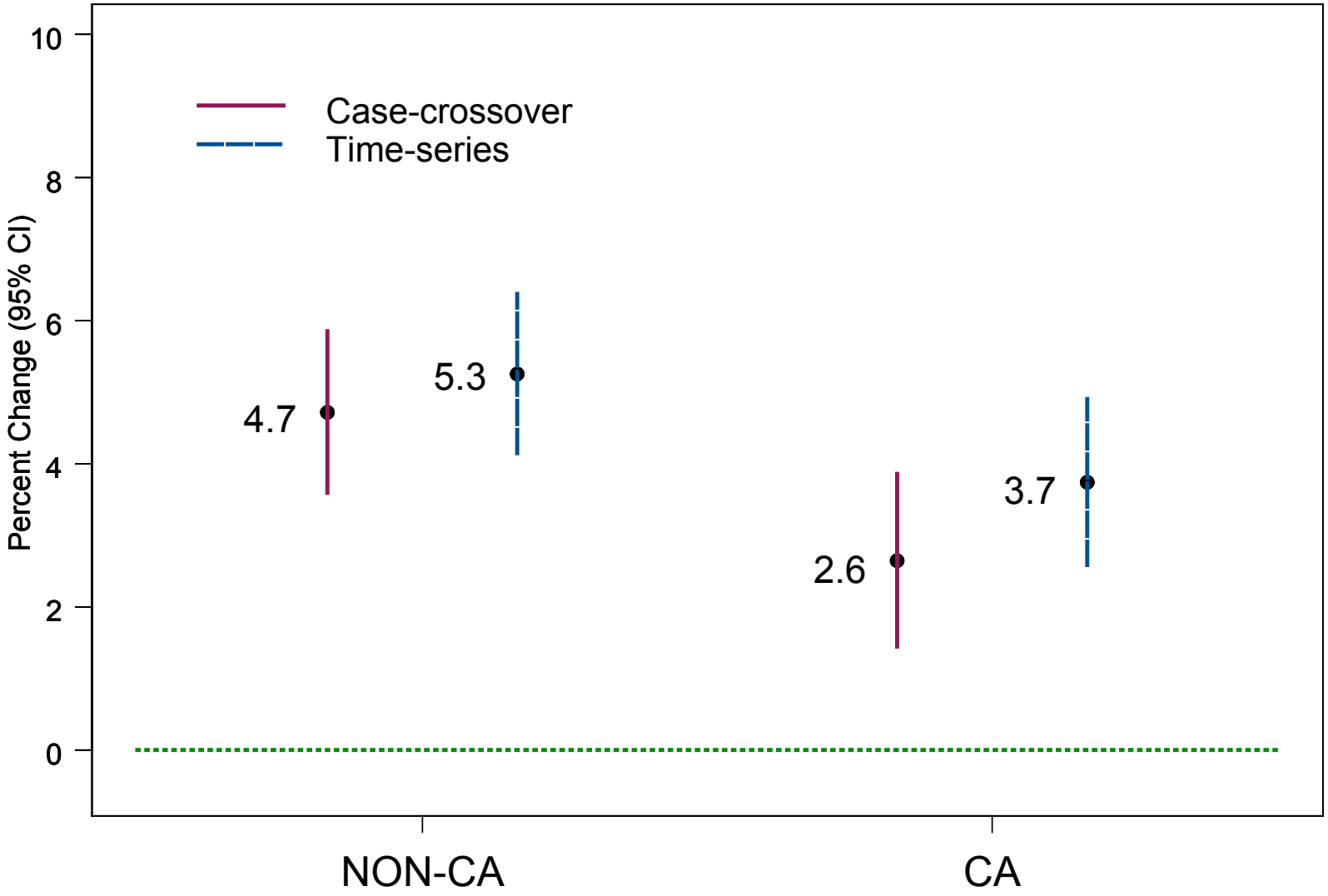


Harvard Nine Counties Study*
May-September, 1999-2003



*Major City within each County Shown

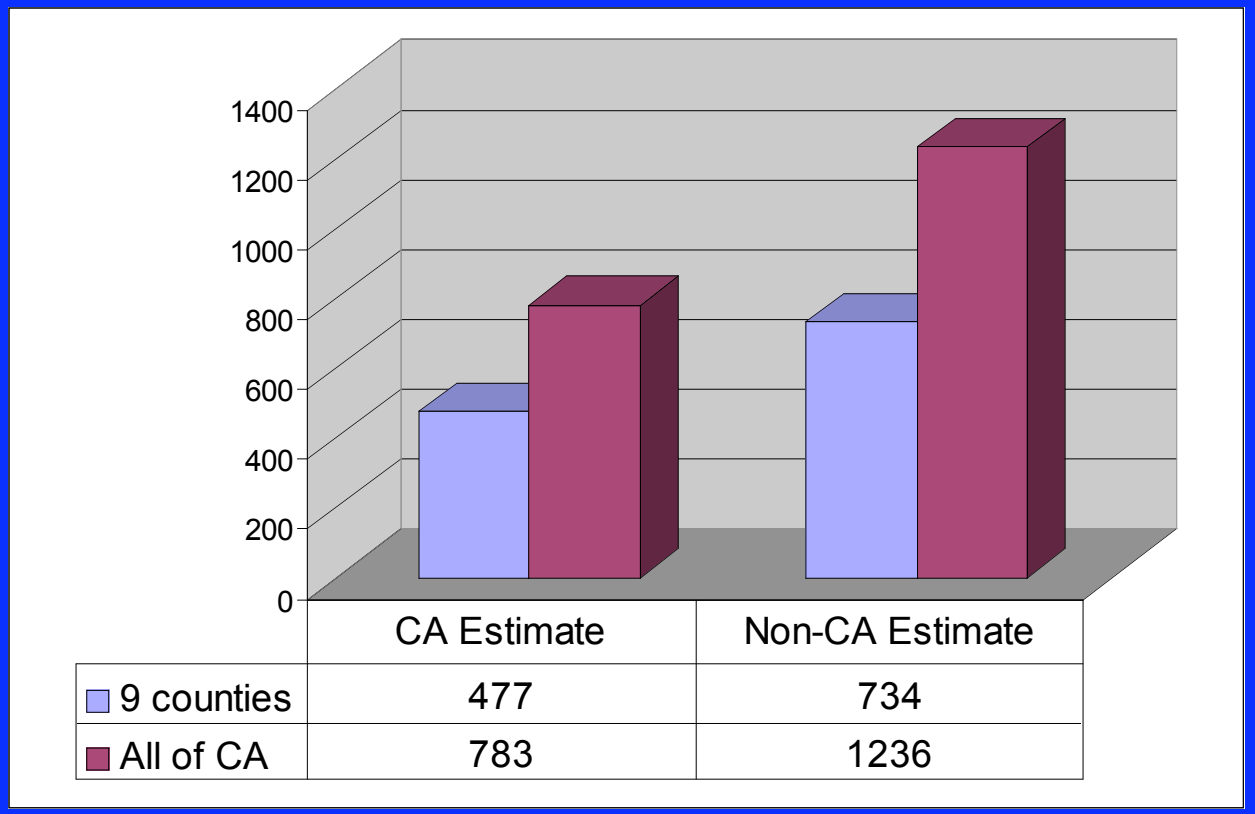
Temperature per 10°F and All-cause Mortality



Future Projections

- Projected temperature increases for one year (2034) from Cayan et al. 2006
- Examined medium sensitive model (GFDL/A2)
- Used CA and non-CA estimates of temperature-mortality association from our study
- Assumed baseline conditions for population size and demographic distribution

Estimated Excess Mortality for the Year 2034



	CA Estimate	Non-CA Estimate
9 counties	477	734
All of CA	783	1236

Projected increase in warm season mortality associated with the rise in temperatures: 0.98-1.55%

Implications

- ~3% increase in all-cause mortality associated with 10°F increase apparent temperature
- Increased risk also found for cardiovascular mortality, elderly, young children, Blacks
- Mortality effect of apparent temperature is immediate
- Temperature effect appears independent of air pollutants
- Case-crossover and time-series estimates similar
- Heat wave not necessary to find a temperature-mortality association in CA

Future Research

- Other temperature definitions (min/max temp)
- Further analysis of July 2006 heat wave
- Additional analyses of vulnerable subgroups and interaction with air pollutants
- Morbidity studies to include hospitalizations

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